

REMARKS

This is a full and timely response to the outstanding non-final Office Action mailed September 1, 2004. Through this response, independent claim 1 and dependent claims 4-6 have been amended. Reconsideration and allowance of the application and pending claims 1-8, and 16-18 are respectfully requested.

I. Claim Rejections - 35 U.S.C. § 112

A. Rejections under 35 U.S.C. § 112, Second Paragraph

The Office Action states that claim 5 is rejected under 35 U.S.C. § 112, second paragraph. In particular, the Office Action states the following:

Claim 5 has been rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. In claim 5, the recitation of the “second transistor” is confusing with respect to the already recited “second switching transistor”. It appears that “second transistor” should be –second sink transistor--.

In response to the rejection, Applicants have amended claim 5 and corresponding language in claim 6, which depends from claim 5. In view of the amendments to claim 5, it is respectfully asserted that claim 5 defines the invention in the manner required by 35 U.S.C. § 112. Accordingly, Applicants respectfully request that the rejections to these claims be withdrawn.

II. Claim Rejections - 35 U.S.C. § 102(b)

A. Statement of the Rejection

Claims 1-15 have been rejected under 35 U.S.C. § 102(b) as allegedly being anticipated by *Park, et al.* (“*Park*,” U.S. Pat. No. 5,729,178). Applicants respectfully traverse this rejection, and respectfully request that the next response include an examination of the claims added in the preliminary amendment (16-18) to the RCE filed on July 9, 2004.

B. Discussion of the Rejection

It is axiomatic that “[a]nticipation requires the disclosure in a single prior art reference of each element of the claim under consideration.” *W. L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1554, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983)(emphasis added). Therefore, every claimed feature of the claimed invention must be represented in the applied reference to constitute a proper rejection under 35 U.S.C. § 102(b). In the present case, not every feature of the claimed invention is represented in the *Park* reference.

Independent Claim 1

As recited in independent claim 1, Applicants claim (with emphasis added):

1. A low power ***voltage-to-current converter*** for use in a phase locked loop, comprising:
 - an input stage comprising:
 - a pair of differential signal input terminals operable to receive differential input signals;
 - first and second switching transistors each coupled to one of the pair of differential signal input terminals;
 - first and second complementary transistors coupled to the first and second switching transistor, respectively;

a *first output stage and a second output stage*, the first output stage coupled to the second output stage, the first output stage coupled to the first complementary transistor of the input stage;

and

a non-differential output terminal coupled to the first output stage, where the output terminal is operable to transmit an output current signal as a function of the differential input signals and *independent of a coupled load*.

Park does not disclose all of the features of independent claim 1. For example, *Park* does not disclose a “*first output stage and a second output stage*, the first output stage coupled to the second output stage, the first output stage coupled to the first complementary transistor of the input stage,” as recited in independent claim 1. The output in *Park* is a single-stage output, not a two-stage output. The Office Action alleges the following:

Park et al. discloses, in Fig. 8, a circuit comprising: ... “an output stage” having “a first output stage (Mc15 and Mc16)”...and “a second output stage Mc5 and Mc12”); ... all connected and operating similarly as recited by Applicant.

Applicants respectfully disagree. What the Office Action is designating as output stages is, on the contrary, at least in part designated in the *Park* specification as an input stage. In particular, column 8, lines 40-45 provides as follows:

Referring to FIG. 8, there is depicted a circuit diagram of the CMFB circuit 300 shown in FIG. 6, which provides a common mode voltage on the VCM terminal thereof. The CMFB circuit 300 includes a pMOS input stage amplifier consisting of Mc1 to Mc7 and a nMOS input stage amplifier consisting of Mc8 to Mc14 which provide current outputs responsive to voltage inputs.

Thus, MC1-Mc14 are all components corresponding to two input stages. As MC5 and MC12 fall within this range, it is not correct to assert that these same components are part of

the *second output stage*. Thus, Applicants respectfully request that the rejection to independent claim 1 be withdrawn.

Additionally, *Park* does not disclose a *voltage-to-current converter* that provides a current output signal that is *independent of a coupled load*, as recited in independent claim 1. A load independence feature is well-known for *voltage-to-current converters*, and was added in the preliminary amendment to the RCE filed on July 9, 2004 to further emphasize the nature of the circuit of claim 1. In contrast, *Park* discloses a fully differential folded cascode CMOS operational amplifier having adaptive biasing and common mode feedback, as indicated in the title. FIG. 8, which has been used in the Office Action, is a common mode feedback (CMFB) circuit. (See col. 8, line 40 and col. 9, lines 33-37.) Applicants have included Exhibit A and Exhibit B to assist the Examiner in understanding how voltage-to-current converters are distinct from the common mode feedback circuit disclosed in *Park*. Exhibit A is a copy of a web-site entitled, "Electronic Definitions," which provides that a voltage-to-current converter is "a circuit that is equivalent to a controlled current source. The input voltage controls the current. The current is then constant and independent of the load resistance." Exhibit B is a copy from the textbook entitled, *Micro-Electronic Circuits, Digital and Analog Circuits and Systems*, McGraw-Hill Book company, pages 572-573. The pages shown in Exhibit B describe a voltage-to-current converter, and how it is often used to "convert a voltage signal to a proportional output current," and further that the current is independent of the load. Although a current may be available at the output of the *Park* common mode feedback circuit (CMFB) of FIG. 8, as explained in the final Office Action dated April 9, 2004, such a possibility does not make the CMFB circuit of *Park* a *voltage-to-current*

converter, as recited in claim 1. Simply having a current at the common mode voltage terminal of the CMFB of *Park* does not necessarily mean that the current will be independent of the value of the load impedance. Although the input stages of the CMFB of *Park* are configured as transconductance amplifiers (see col. 8, lines 61-65), the output stage converts the current provided by the transconductance amplifiers to a voltage output, or more particularly, to a common-mode voltage output (see col. 8, lines 48-50). As the circuit of FIG. 8 operates as a common-mode feedback circuit, equating such a circuit to a “voltage-to-current converter” as described in claim 1 renders the CMFB circuit of *Park* unsuitable for its intended purpose. In other words, there is no indication of need or desirability in the *Park* disclosure of providing a transconductance output, as *Park* deliberately added a current-to-voltage conversion. Thus, why add conversion circuitry if it is not needed or wanted? If inherency is being argued, a basis in fact and/or technical reasoning must be provided to reasonably support the determination that the allegedly inherent characteristic necessarily flows from the teachings of the applied prior art. (see MPEP 2112). Further, if a reference would be “rendered inoperable for its intended purpose” when it is modified for use as prior art, then the reference “teaches away” and should not be used. *In re Gordon*, 733 F.2d 900, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984). As the CMFB circuit of *Park* is not a ***voltage-to-current converter***, as provided in claim 1, Applicant respectfully requests that the rejection to claim 1 be withdrawn.

Because independent claim 1 is allowable over *Park*, dependent claims 2-8 and 16-18 are allowable as a matter of law for at least the reason that the dependent claims 2-8 and 16-18 contain all the elements of their respective base claim. See, e.g., *In re Fine*, 837 F.2d 1071 (Fed. Cir. 1988)

In addition, Applicants also respectfully traverse the rejections of the dependent claims on other grounds. For example, Applicants respectfully submit that *Park* does not disclose the features of claim 5, namely “wherein the first output stage comprises a first current source transistor, a second current source transistor, a first current sink transistor, and a second current sink transistor, and the second output stage comprises a second stage current source transistor and a ***bandgap reference receive transistor***.” Since *Park* does not disclose a ***bandgap reference receive transistor***, Applicants thus respectfully request that the rejection to claim 5 be withdrawn.

Similarly, with regard to claims 6-7, which depend from claim 5, Applicants respectfully submits that *Park* does not disclose all of the claimed features. The Office Action makes reference to claims 6 and 7 and a “bandgap reference signal”, which is received by the ***bandgap reference receive transistor*** recited in claim 5 (as further described in claims 6 and 7). In particular, the Office Action alleges the following:

With respect to claims 6-7, such no longer recite that the “output stages” comprises “a bandgap reference circuit.” The claims now only recite the receipt of “a bandgap reference signal”, which is clearly intended use recitation. Since V2 is capable of being a “bandgap reference signal”, such meets the claim language.

Applicants respectfully disagree. The dependent claims must be read in the context of the limitations of the claims from which they depend. V2 cannot be a “bandgap reference signal” if it is already in use as a differential input signal, as recited in the Office Action (*i.e.*, the Office Action has already provided a use for V2 (“a pair of differential signal input terminals (V1 and V2)”), which is not for use as a bandgap

reference signal). Thus, Applicants respectfully request that the rejection to claims 6-7 be withdrawn.

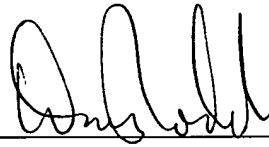
As another example, Applicants submit that *Park* does not disclose “a biasing transistor coupled to a bias signal coupled to the output of a charge pump of the phase locked loop and to a supply voltage, wherein the biasing transistor is configured to generate a bias current for the first and second complementary transistors of the input stage,” as recited in dependent claim 8. Neither a bias transistor nor a charge pump are disclosed in Figure 8 of *Park*, and thus Applicants respectfully request that the rejection to dependent claim 8 be withdrawn.

Due to these clear shortcomings of the *Park* reference, Applicants respectfully assert that *Park* does not anticipate Applicants’ claims. Therefore, Applicants respectfully request that the rejection of these claims be withdrawn.

CONCLUSION

Applicants respectfully submits that Applicants' pending claims are in condition for allowance. Favorable reconsideration and allowance of the present application and all pending claims are hereby courteously requested. If, in the opinion of the Examiner, a telephonic conference would expedite the examination of this matter, the Examiner is invited to call the undersigned attorney at (770) 933-9500.

Respectfully submitted,



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Exhibit A

Definition for voltage to current converter

HOME O A B C D E F G H I J K L M N O P Q R S T U V W X Y

VOLTAGE TO CURRENT CONVERTER

What is voltage to current converter in electronics?

Read the following to find out:

voltage to current converter

a circuit that is equivalent to a controlled current source. The input voltage controls the current. The current is then constant and independent of the load resistance.

Low Voltage Amplifiers

from the World Leader in high performance Analog.

Voltage Comparator

High-Speed & Micropower Comparators Designed for the Unexpected

Low-Noise DC Bias

Voltage/Power/Bias Supply for CMOS, CCD, FPA Test and Characterization

Voltage Reference

Search Our Huge Selection of Quality Electronic Components Today

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Exhibit B

R'_{p2} is the parallel combination of all the resistors tied to the noninverting node with the exception of R'_2 ; that is, $R'_{p2} = R'_1 \parallel R'_3 \parallel R'_4 \parallel \dots \parallel R'_n$.

For n equal resistors each of value R'_2 ,

$$\frac{R'_{p2}}{R'_2 + R'_{p2}} = \frac{R'_2/(n-1)}{R'_2 + R'_2/(n-1)} = \frac{1}{n} \quad (16-4)$$

and
$$v_+ = \frac{1}{n} (v'_1 + v'_2 + \dots + v'_n) \quad (16-5)$$

The output is given by Eqs. (16-3) and (16-5).

It is possible to perform analog addition and subtraction simultaneously with a single OP AMP by replacing the resistor R in Fig. 16-3 by the n input voltages and resistors of Fig. 16-2. Again superposition is used to find the contribution to v_o from any of the input voltages. It should be emphasized that, when one of the voltages v_1, v_2, \dots, v_n is under consideration, then the positive input terminal is effectively grounded (if the bias current is negligible). Similarly when one of the voltages v'_1, v'_2, \dots, v'_n is under consideration, then R in Fig. 16-3 represents the parallel combination of R_1, R_2, \dots, R_n .

Voltage-to-Current Converter (Transconductance Amplifier)

Often it is desirable to convert a voltage signal to a proportional output current. This is required, for example, when we drive a deflection coil in a television tube. If the load impedance has neither side grounded (if it is floating), the simple circuit of Fig. 16-2 with R' replaced by the load impedance Z_L is an excellent *voltage-to-current converter*. For a single input $v_1 = v_s(t)$, the current in Z_L is

$$i_L = \frac{v_s(t)}{R_1} \quad (16-6)$$

Note that i is independent of the load Z_L , because of the virtual ground of the operational amplifier input. Since the same current flows through the signal source and the load, it is important that the signal source be capable of providing this load current. On the other hand, the amplifier of Fig. 16-4a

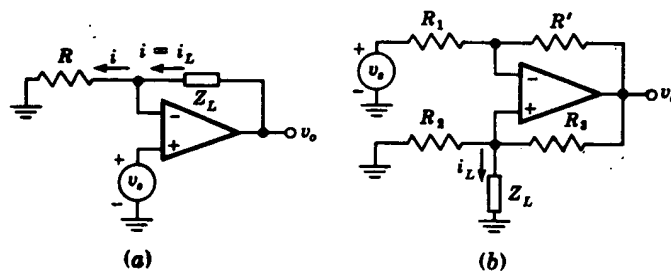


Figure 16-4 Voltage-to-current converter for (a) a floating load and (b) a grounded load Z_L .

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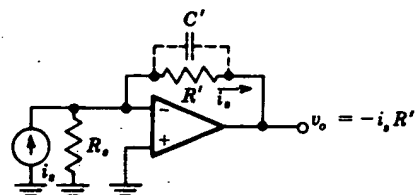


Figure 16-5 Current-to-voltage converter.

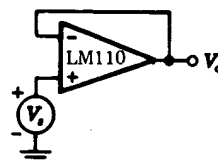


Figure 16-6 A voltage follower, $V_o = V_s$.

requires very little current from the signal source due to the very large input resistance seen by the noninverting terminal.

If the load Z_L is grounded, the circuit of Fig. 16-4b can be used. In Prob. 16-6 we show that if $R_3/R_2 = R'/R_1$, then

$$i_L(t) = - \frac{v_s(t)}{R_2} \quad (16-7)$$

Current-to-Voltage Converter (Transresistance Amplifier)

Photocells and photomultiplier tubes give an output current which is independent of the load. The circuit in Fig. 16-5 shows an operational amplifier used as a current-to-voltage converter. Due to the virtual ground at the amplifier input, the current in R_s is zero and i_s flows through the feedback resistor R' . Thus the output voltage v_o is $v_o = -i_s R'$. It must be pointed out that the lower limit on current measurement with this circuit is set by the bias current of the inverting input. It is common to parallel R' with a capacitance C' to reduce high-frequency noise and the possibility of oscillations. The current-to-voltage converter makes an excellent current-measuring instrument since it is an ammeter with zero voltage across the meter.

DC Voltage Follower

The simple configuration of Fig. 16-6 approaches the ideal *voltage follower*. Because the two inputs are tied together (virtually), then $V_o = V_s$ and the output follows the input. The LM110 (National Semiconductor Corporation) is specifically designed for voltage-follower usage and its output is internally connected to the inverting output. It has extremely high input resistance ($10^6 \text{ M}\Omega$), very low input current (1 nA), very low output resistance ($0.75 \text{ }\Omega$), a bandwidth of 10 MHz, and a gain of 0.9997. The LM110 may oscillate if the source resistance is too small and it may be necessary to add about $10 \text{ k}\Omega$ in series with the source.

16-2 DIFFERENTIAL (INSTRUMENTATION) AMPLIFIERS¹⁻⁶

The differential-input single-ended-output instrumentation amplifier is often used to amplify inputs from transducers which convert a physical parameter and

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